# MONTHLY NOTICES

OF THE

# ROYAL ASTRONOMICAL SOCIETY.

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G. B. AIRY, Esq., President, in the Chair.

Lieut.-Col. Patrick Stewart, R.E., 8 Lower Belgrave Street, and
J. Wm. Harris, Esq. M.R.C.S.L., Southernhay, Exeter,
were balloted for and duly elected Fellows of the Society.

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*Determination of the Sun's Mean Horizontal Equatoreal Parallax, from a Comparison of Corresponding Observations of N.P.D. of Mars and Stars, made at the Royal Observatory, Greenwich, and the Government Observatory, Williamstown, Victoria, Australia, during the Opposition of* 1862. By E. J. Stone, Esq.

In his Tables of *Mars*, published in the *Annals of the Imperial Observatory*, Paris, 1861, M. Le Verrier remarks that it is impossible to reconcile the observations of *Mars* with theory without attributing to the perihelion a motion greater than any which can be obtained, except by a sensible increase of the received planetary masses; that the necessary agreement between theory and observation could be obtained by increasing the received value of the mass of the Earth in proportion to the Sun's mass, by not less than a tenth part, but that such an increase in the received value of the Earth's mass would necessitate a corresponding increase in the received value of the Sun's mean equatoreal horizontal parallax of a thirtieth part.

M. Le Verrier deduced the same result from a discussion of the latitudes and the motion of the node of *Venus*. The dif-

ficulties raised in the theory of *Mercury*, although not removed, were slightly diminished by the same increase of the Earth's mass.

In his Solar Tables, M. Le Verrier has adopted the value $8''{\cdot}95$ for the mean equatoreal horizontal solar parallax; this value was obtained by determining from observation the coefficient of the lunar equation and assuming the mean lunar parallax and data furnished by the theories of Precession and Nutation.

The way in which M. Le Verrier has thus evolved from the theories of *Venus*, the Earth, and *Mars*, the necessity of a value of the mean solar parallax much greater than the usually received value $8''{\cdot}57$, and not differing greatly from $8''{\cdot}95$, must render it extremely probable that the true value of the Sun's mean parallax does not differ greatly from that quantity.

It is the object of the present paper to lay before the Society a redetermination of the Sun's mean equatoreal horizontal parallax.

Some time since Robert L. S. Ellery, Esq., the Director of the Government Observatory, Williamstown, Victoria, Australia (Longitude E. $9^h\,39^m\,39^s{\cdot}3$, Latitude S. $37^\circ\,52'\,6''{\cdot}6$), forwarded to the Astronomer Royal a fine series of meridian declination observations of *Mars*, made during the period extending from 1862, August 20, to the middle of the following November. These observations the Astronomer Royal has kindly placed in my hands for comparison with the corresponding Greenwich observations. I have thus deduced 22 independent determinations of the Sun's mean solar parallax.

The method of reduction pursued has been as follows:—The North Polar Distances of *Mars* at the Greenwich and Williamstown transits, and the geocentric distances of the planet, have been obtained, where necessary, by interpolation from the *Nautical Almanac*. The Greenwich observations were then compared with the tables; and from the system of errors thus exhibited a curve was roughly drawn to represent the change of error: the only use of this curve was to determine the small change of error of tabular places between the transits of *Mars* over the meridians of Williamstown and Greenwich.

The factors of the Sun's mean horizontal equatoreal parallax in the expressions for the parallax in declination were then calculated, using the Astronomer Royal's value of the ratio of the principal axes of the earth, viz. $\frac{299}{300}$; and the observations of *Mars* compared with the same stars at Greenwich and Williamstown. In weighting the observations, I have considered the probable error of an observation of the centre of *Mars*, deduced from observations of the two limbs, equal to the probable error of a good star observation: the weights are the strict theoretical weights, and I have considered all

observations as equally good, unless the observer has expressed himself dissatisfied with the observation at the time of making it. All the Greenwich observations that could be combined with observations at Williamstown, without trusting to the interpolation of change of tabular error for more than two days, and without using different stars of comparison at the two stations, have been so combined, and the results are given. The following are the separate results:—

| 1862. | Mean Horizontal Equatoreal Parallax. | Weight. | 1862. | Mean Horizontal Equatoreal Parallax. | Weight. |
|---|---|---|---|---|---|
| | ″ | | | ″ | |
| Aug. 25 | 9·240 | 3·1329 | Oct. 3 | 9·024 | 2·9241 |
| 27 | 9·646 | 3·4969 | 8 | 8·962 | 2·8561 |
| 28 | 9·416 | 2·2201 | 9 | 9·024 | 2·8224 |
| Sept. 3 | 8·868 | 1·7689 | 11 | 8·748 | 2·7556 |
| 10 | 9·161 | 4·2436 | 18 | 8·497 | 0·5329 |
| 11 | 8·756 | 4·0000 | 22 | 8·929 | 2·4025 |
| 16 | 8·844 | 3·7249 | 24 | 8·559 | 1·4884 |
| 17 | 9·148 | 2·8224 | 29 | 8·708 | 3·6100 |
| 21&22 | 8·684 | 4·3264 | Nov. 3 | 8·620 | 0·4356 |
| 23 | 9·074 | 4·3681 | 9&10 | 8·932 | 2·2201 |
| 25 | 9·052 | 2·9584 | 12 | 9·006 | 1·5876 |

The mean result is 8″·932, and if we assume the probable error of a single observation = 0″·25, the probable error of the above result would be 0″·032.

The comparison of the Greenwich and Williamstown observations, therefore, leads to the value 8″·932 ± 0″·032 for the Sun's mean horizontal equatoreal parallax,— a value differing but slightly from the value assumed by M. Le Verrier in his Solar Tables.

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M. Otto von Struve, Associate of the Society, gave an account of a remarkable local deviation in the direction of gravity, which has lately been observed in Russia. It is the more remarkable from its occurring in a country which is totally free from mountains, and which, though slightly undulating, may be described as a very level plain country.

On computing, upon the best elements for the figure of the earth, the longitudes and latitudes of the points in the Russian triangulation, it was found that the observed co-latitude of the Observatory of Moscow was about 8″ greater than that given by the geodetic connexion with other well-determined points of the survey. To put this beyond doubt, it was compared with numerous triangulation-stations in its neighbourhood, and the

results, with only such discordances as may always be expected, were all of the same kind. The high character of Professor Schweizer, the observer at Moscow, placed the validity of the astronomical determination beyond all suspicion. Professor Schweizer, then, with such assistance as he could command, repeated the observations at numerous points in the vicinity of Moscow. The following is the general result:

Upon the map below there will be remarked three somewhat irregular lines, nearly in the direction E.N.E. and W.S.W. Along the central line the observed co-latitudes agreed sensibly with the geodetic co-latitudes. To the north of that central line, for a considerable distance, the observed co-latitudes are too great, and to the south of that central line they are too small. The upper and lower lines show the places of maximum discordance; the upper line passes sensibly through the Observatory of Moscow. The disturbances appear to have been traced to about one degree of longitude on each side, east and west, where their magnitudes are reduced to about one-half of those in the neighbourhood of Moscow.

The amount of disturbance near Moscow, in relation to the distance of a place from the central line, is nearly as follows:—

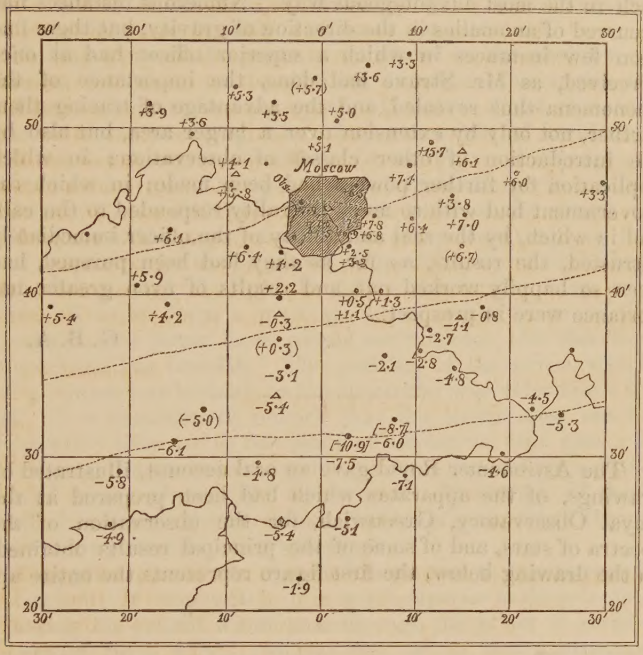
| | | | |
|---|---|---|---|
| At distance 0 | ... ... ... ... ... | disturbance = 0 | |
| 3·8 versts | = 2·5 English miles | ... ... ... | 2″·22 |
| 12 ... | = 8 ... ... ... | ... ... | 7·80 |
| 20 ... | = 13 ... ... ... | ... ... | 5·15 |
| 26·59 ... | = 18 ... ... ... | ... ... | 2·10 |
| 34 ... | = 23 ... ... ... | ... ... | 0 |

Its magnitude is sensibly the same, but with opposite signs, at equal distances north and south of the central line. The deviation at distances not exceeding 8 miles from the central line, is not less than $\frac{1}{60}$th part of the angle made by the verticals. Its sign is that corresponding to a deficiency of matter beneath the central line; and it does not apparently admit of explanation by any other supposition, as by an excess of density of the earth's crust in two places, one north and the other south, because beyond the limits above stated there is no trace of sensible disturbance.

According to Professor Schweizer's calculations, the volume of deficiency of matter, of the same density as the earth's crust, must be 1·2 cubic German geographical miles (the German geographical mile is $\frac{1}{15}$th of a mean degree of latitude). This supposes that the deficiency is at no great depth below the central line. If the density of the earth's crust, in that part, be only partially diminished, the volume of matter so affected must be increased in a corresponding proportion.

M. O. Struve, struck with the importance of these observations, and with the probable advantage of pursuing them

further, has applied for, and has obtained, from the Imperial Government, the means of enabling Professor Schweizer to examine the local disturbances at numerous points, in a district of considerable extent, connected with the general survey by a secondary triangulation. The small map below embraces but a portion of the country to be thus examined. It is intended that the comparison of observed and geodetic co-latitudes shall




The shaded space is the city of Moscow. The observatory is in its upper left-hand corner.

The figures at other stations denote the excess of observed co-latitudes, in seconds. Those inclosed in brackets are less certain.

be extended, especially to the east and west, until the discrepancies disappear. When these limits are ascertained, it is intended, on Mr. Struve's suggestion, that longitudes and azimuths shall be observed at numerous stations. The elevation of different points, and the general form of the district, will also be ascertained by levelling, in order to eliminate the very small effects which may be produced by the inequalities of the surface. And pendulum-experiments are to be made, for ascertaining the effect of the disturbing cause on the force of gravity.

The extension of the survey is already begun by the Imperial General-Staff (Etat-Major). And for the other operations, Professor Schweizer will receive all the assistance which the influence of Russian scientific bodies can obtain.

The President remarked on this interesting communication, that it was one of great value, not merely for the importance of the results obtained, but also as an instance of extraordinary combination of different powers of different officers, directed each in the most advantageous way. Numerous instances had occurred of anomalies in the direction of gravity, but there had been few instances in which a superior officer had at once perceived, as Mr. Struve had done, the importance of the phenomena thus revealed, and the advantage of tracing them further, not only by extension over a larger area, but also by the introduction of other classes of observation; in which application for further powers had been made; in which the Government had with so much liberality responded to the call; and in which, by the zeal and ability of the officer immediately intrusted, the results, as far as they had been pursued, had been so happily worked out, and results of even greater importance were in prospect.

G. B. A.

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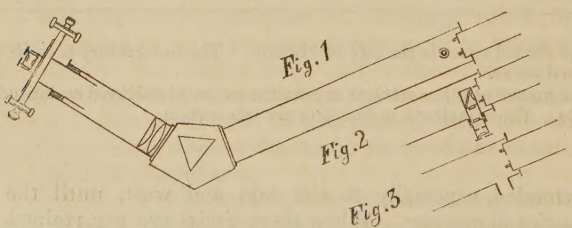
The Astronomer Royal gave an oral account, illustrated by drawings, of the apparatus which had been prepared at the Royal Observatory, Greenwich, for the observation of the spectra of stars, and of some of the principal results obtained. In the drawing below, the first figure represents the entire ap-




paratus, in section; the second and third figures represent the right-hand portion of the apparatus in a section through the axis of the long tube, but at right angles to the former section.

In fig. 1, the smaller tube at the right-hand is for insertion in the socket upon the breech-piece of the telescope of the great equatoreal. To carry the apparatus steadily, (great accuracy of position is not needed) a temporary frame is screwed to the

sides of the telescope tube. The right-hand tube is thrust into the socket so far that the image of the star is formed in the moderately small hole in the inner end of that smaller tube. The pencil of light from the object-glass, which has converged to form the image of the star, then diverges and falls in a wide and divergent state upon the prism; after emergence it is received on a combination of lenses, which causes the pencils for the different colours to converge. It is seen thus that a spectrum may be formed at the place of the micrometer; it is necessary now to explain how breadth is given to the spectrum.

For this purpose the prism is not placed in the position of minimum deviation, or the position in which the angles of incidence and emergence are equal. It is so inclined that the angle of emergence is greater than the angle of incidence. With this arrangement, the change in the degree of divergence of the extreme rays of the pencil is different as regards (on the one hand) rays in the upper and lower parts of the pencil, or in the plane of the paper, and (on the other hand) rays in the plane perpendicular to the paper. The difference is such that, when after passing through the lenses the former have converged so as to form a pure spectrum at the place of the micrometer, the latter have passed convergence, and therefore the spectrum has breadth. The position of the prism, which gave a convenient breadth to the spectrum, was determined by trial. It is necessary to remark that the lenses must not be achromatic; they are in fact made of dispersive flint glass; if achromatic, the spectrum would have been formed in a plane inclined to the plane of the micrometer. The whole of these peculiarities were calculated numerically on geometrical theory before the construction was attempted.

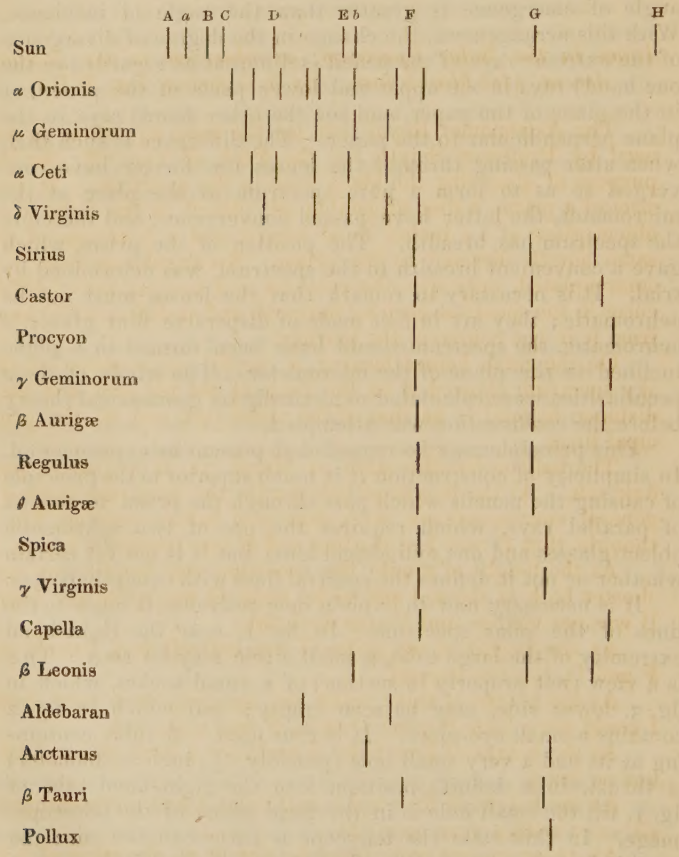
This principle may be regarded at present as experimental. In simplicity of construction it is much superior to the principle of causing the pencils which pass through the prism to consist of parallel rays, which requires the use of two achromatic object-glasses and one cylindrical lens; but it is not yet certain whether or not it defines the spectral lines with equal sharpness.

It is necessary now to explain how reference is made to the lines of the solar spectrum. In fig. 1, near the right-hand extremity of the large tube, a small circle may be seen. This is a view (not properly in section) of a small socket, which in fig. 3, lower side, may be seen empty; and which in fig. 2 contains a small eye-piece. It is thus used. A tube, containing at its end a very small hole (possibly $\frac{1}{300}$ inch in diameter) is thrust, in a definite position, into the right-hand tube of fig. 1, till the small hole is in the focal plane of the telescope-image. In this state the telescope is turned to the sun; the small hole represents a star of solar matter; and its spectrum may be observed and measured. An eyepiece with diagonal reflector, and carrying a wire in its focus, is thrust into the small socket, as in fig. 2, and the position of the solar hole with

reference to the wire is carefully observed. Then, when a star is to be observed, the small eyepiece is thrust in, the telescope is moved till the star's image has the same position in regard to the wire which the solar hole had, and then it is certain that the star occupies precisely the place of the solar hole; then the small eyepiece is withdrawn, and the spectrum is observed and measures are made with the micrometer.

For reading the comb of the micrometer there is an annular reflector to illuminate the field, not shown in the drawing.

The following sketch exhibits lines whose positions have been measured by Mr. Carpenter; numerous lines have been seen but not measured.




On this sketch Mr. Carpenter remarks:—

This diagram is only intended to show the positions of the

lines; no attempt has been made to illustrate their characters or their different intensities. The stellar lines are generally nebulous, resembling the solar line H; in the first four stars on the diagram they are, however, much more diffused on the side opposite to the red end of the spectrum.

Since these observations were communicated to the Society two more lines have been detected in the spectrum of *Arcturus;* one coincident with solar D, the other between it and solar C.

G. B. A.

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*Lines in the Solar Spectrum, as observed in the Balloon Ascent, 31st March last.* By J. Glaisher, Esq. F.R.S.

The Astronomer Royal lent me the same apparatus as was used by Professor Smyth on the Peak of Teneriffe, for the purpose of observing the black lines in the spectrum. It consists of a prism, a fine adjustable slit placed in the focus of an object-glass of 14 inches focal length, and a telescope of the same length directed to the prism. No angular measure was contemplated, only eye observations and comparison of differences in the spectrum seen on the earth and at different distances from it in the course of the journey.

On the earth before leaving, a careful examination of the sky spectrum showed B as the limit of the red end, and some distance beyond G as that of the violet end, and all the principal lines.

The balloon left the earth on March 31, at a quarter past four P.M. At the height of half-a-mile the spectrum showed a general correspondence with that seen before starting, but I thought that G was less distinct and B was certainly less so.

At the height of a mile the spectrum was bright, but was shorter both at the red and violet ends, G was quite the limit, B was not visible, and C was doubtful.

At the height of two miles G was entirely lost, I could see F and D, but not beyond.

At the height of three miles the spectrum was very short, I could see a little beyond D to E, F was quite lost.

At the height of four miles I could see a little yellow tinge, but no lines.

At the height of four and a half miles I had no spectrum at all, even with a very open slit.

All those spectra were from the sky at an elevation of 60°; as far as time permitted I looked at a horizontal spectrum, and I did not see any marked difference between it and the spectrum at the higher elevation, at the same time. The general results

of these experiments are, that no line was lost from the spectrum, except through the loss of the spectrum itself, and that the spectrum shortened with increase of elevation.

The shortening of the spectrum with increase of elevation may have been, and most likely was, owing to want of light, (although to my senses there was abundance), the sky was of a deep dark blue, the sun was low, and it is possible the light was insufficient. For this class of observations it will be necessary to have a morning or mid-day ascent, for comparison of results with the preceding as well as to determine whether really the spectrum shortens with elevation or not.

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## *Results of the Meridional Observations of Small Planets; Occultations of Stars by the Moon; and Phenomena of Jupiter's Satellites; observed at the Royal Observatory, Greenwich, in the months of February and March,* 1863.

(*Communicated by the Astronomer Royal.*)

### *Astræa* (5).

| Mean Solar Time of Observation. | R.A. from Observation. | N.P.D. from Observation. |
|---|---|---|
| | h m s | h m s | ° ′ ″ |
| 1863, Feb. 3 | 13 23 41·3 | 10 18 33·47 | 78 57 20 09 |
| 12 | 12 41 48·1 | 10 12 2·42 | 77 44 56·16 |
| 13 | 12 37 5·1 | 10 11 15·20 | 77 36 35·35 |
| 16 | 12 22 53·7 | 10 8 51·07 | 77 11 32·87 |
| 21 | 11 59 11·7 | 10 4 48·03 | 76 30 14·05 |
| 27 | 11 30 55·5 | 10 0 6·47 | 75 43 7·56 |
| 28 | 11 26 15·0 | 9 59 21·72 | 75 35 41·74 |
| Mar. 3 | 11 12 19·1 | 9 57 13·25 | 75 14 10·08 |
| 4 | 11 7 42·5 | 9 56 32·37 | 75 7 17·41 |
| 11 | 10 36 1·6 | 9 52 22·20 | 74 24 7·20 |
| 16 | 10 14 8·0 | 9 50 7·74 | 73 59 2·40 |
| 17 | 10 9 50·2 | 9 49 45·77 | 73 54 41·46 |
| 21 | 9 52 57·5 | 9 48 36·48 | 73 39 18·79 |
| 23 | 9 44 42·1 | 9 48 12·83 | 73 32 56·47 |
| 24 | 9 40 37·0 | 9 48 3·63 | 73 30 6·51 |
| 25 | 9 36 34·1 | 9 47 56·65 | 73 27 27·25 |
| 26 | 9 32 32·8 | 9 47 51·26 | 73 25 0·76 |
| 27 | 9 28 33·7 | 9 47 48·07 | 73 22 49·03 |
| 31 | 9 12 55·6 | 9 47 53·61 | 73 16 6·62 |

## *Victoria* (12).

| Mean Solar Time of Observation. | | R.A. from Observation. | N.P.D. from Observation. |
|---|---|---|---|
| | h m s | h m s | ° ′ ″ |
| 1863, Feb. 13 | 11 37 22·5 | 9 11 22·76 | 87 12 36·29 |
| 16 | 11 22 41·0 | 9 8 28·53 | 86 57 52·78 |
| 17 | 11 17 48·3 | 9 7 31·56 | 86 52 43·48 |
| 28 | 10 24 59·3 | 8 57 55·96 | 85 53 2·85 |
| Mar. 3 | 10 10 57·2 | 8 55 41·27 | 85 36 17·41 |
| 17 | 9 8 8·4 | 8 47 53·81 | 84 20 40·25 |
| 21 | 8 51 6·2 | 8 46 35·02 | 84 1 4·52 |

## *Irene* (14).

| Mean Solar Time of Observation. | | R.A. from Observation. | N.P.D. from Observation. |
|---|---|---|---|
| | h m s | h m s | ° ′ ″ |
| 1863, Feb. 12 | 13 29 29·6 | 10 59 51·76 | 67 36 19·84 |
| 13 | 13 24 52·2 | 10 59 10·11 | 67 27 13·42 |
| 14 | 13 20 13·6 | 10 58 27·32 | 67 18 10·24 |
| 16 | 13 10 52·7 | 10 56 57·95 | 67 0 18·92 |
| 17 | 13 6 10·7 | 10 56 11·76 | 66 51 32·73 |
| 28 | 12 13 38·3 | 10 46 52·86 | 65 26 2·62 |
| Mar. 3 | 11 59 12·6 | 10 44 14·40 | 65 7 17·03 |
| 4 | 11 54 24·2 | 10 43 21·80 | 65 1 32·69 |
| 17 | 10 52 52·5 | 10 32 55·12 | 64 13 35·83 |
| 21 | 10 34 33·2 | 10 30 19·08 | 64 9 20·45 |
| 23 | 10 25 32·8 | 10 29 10·25 | 64 9 1·52 |
| 24 | 10 21 4·8 | 10 28 38·11 | 64 9 20·63 |
| 25 | 10 16 38·9 | 10 28 8·04 | 64 9 57·18 |
| 26 | 10 12 14·5 | 10 27 39·47 | 64 10 51·05 |
| 27 | 10 7 51·8 | 10 27 12·60 | 64 12 2·57 |
| 31 | 9 50 39·6 | 10 25 43·74 | 64 19 39·93 |

## *Urania* (80).

| Mean Solar Time of Observation. | | R.A. from Observation. | N.P.D. from Observation. |
|---|---|---|---|
| | h m s | h m s | ° ′ ″ |
| 1863, Feb. 5 | 8 9 48·4 | 5 11 42·11 | 65 36 22·02 |

## *Ariadne* (43).

| Mean Solar Time of Observation. | | R.A. from Observation. | N.P.D. from Observation. |
|---|---|---|---|
| | h m s | h m s | ° ′ ″ |
| 1863, Feb. 14 | 10 48 27·4 | 8 26 16·21 | 75 7 34·27 |
| 17 | 10 33 49·5 | 8 23 25·59 | 74 58 8·07 |
| 18 | 9 42 4·7 | 8 14 54·32 | 74 27 39·58 |

## *Bellona* (28).

| Mean Solar Time of Observation. | R.A. from Observation. | N.P.D. from Observation. |
|---|---|---|
| h m s | h m s | ° ′ ″ |
| 1863, Feb. 3 12 29 22·6 | 9 24 5·86 | 76 53 46·05 |
| 12 11 46 46·2 | 9 16 51·42 | 75 34 43·19 |
| 13 11 42 2·7 | 9 16 3·78 | 75 26 1·69 |
| 14 11 37 20·0 | 9 15 16·81 | 75 17 20·50 |
| 16 11 27 55·9 | 9 13 44·24 | 75 0 13·22 |
| 17 11 23 15·2 | 9 12 59·34 | 74 51 45·05 |
| 21 11 4 39·4 | 9 10 6·77 | 74 18 46·00 |
| 27 10 37 17·3 | 9 6 19·39 | 73 32 34·51 |
| 28 10 32 47·5 | 9 5 45·45 | 73 25 22·98 |
| Mar. 2 10 23 53·4 | 9 4 42·97 | 73 11 20·49 |
| 3 10 19 28·9 | 9 4 14·34 | 73 4 33·56 |
| 4 10 15 4·6 | 9 3 45·84 | 72 57 57·15 |
| 17 9 20 23·8 | 9 0 11·22 | 71 46 54·03 |
| 21 9 4 32·5 | 9 0 3·55 | 71 30 59·42 |
| 23 8 56 47·2 | 9 0 10·14 | 71 24 7·74 |
| 24 8 52 57·3 | 9 0 16·08 | 71 20 55·13 |
| 25 8 49 9·2 | 9 0 23·92 | 71 17 55·65 |
| 26 8 45 22·3 | 9 0 33·00 | 71 15 0·49 |
| 27 8 41 37·8 | 9 0 44·41 | 71 12 25·96 |
| 31 8 26 55·2 | 9 1 45·65 | 71 3 29·85 |

## *Europa* (52).

| Mean Solar Time of Observation. | R.A. from Observation. | N.P.D. from Observation. |
|---|---|---|
| h m s | h m s | ° ′ ″ |
| 1863, Feb. 3 10 4 41·3 | 6 59 0·82 | 70 13 4·54 |
| 9 9 38 14·0 | 6 56 8·47 | 69 50 33·65 |
| 11 9 29 36·9 | 6 55 23·03 | 69 43 28·00 |
| 13 9 21 5·6 | 6 54 43·51 | 69 36 30·49 |
| 14 9 16 52·4 | 6 54 26·17 | 69 33 5·47 |
| 16 9 8 30·7 | 6 53 56·13 | 69 26 27·75 |

## *Diana* (78).

| Mean Solar Time of Observation. | R.A. from Observation. | N.P.D. from Observation. |
|---|---|---|
| h m s | h m s | ° ′ ″ |
| 1863, Mar. 27 11 29 23·7 | 11 48 57·86 | 96 56 25·75 |
| 31 11 10 0·4 | 11 45 17·59 | 96 46 33·45 |

All the observations of N.P.D. have been corrected for Refraction and Parallax.

### *Occultations of Stars by the Moon.*

| Day of Observation. 1863. | Phenomenon. | Moon's Limb. | Mean Solar Time. h m s | Observer. |
|---|---|---|---|---|
| Feb. 11 | 15 Geminorum, disapp. | Dark | 9 43 15·8 | S. |
| Mar. 2 | $\alpha$ Cancri, disapp. | Dark | 11 48 54·8 | C. |

The star, the occultation of which was observed on Jan. 27, and printed without a name in the last number of the *Monthly Notices*, page 174, was $\delta$ *Arietis*.

### *Phenomena of Jupiter's Satellites.*

| Day of Observation. 1863. | Satellite. | Phenomenon. | Mean Solar Time. h m s | Observer. |
|---|---|---|---|---|
| Feb. 16 | I | Eclipse, disapp. | 14 2 27·1 | E. |
| 17 | I | Ingress, first cont. | 12 3 35·7 | R. |
| ,, | I | ,, bisection | 12 6 35·2 | R. |
| ,, | I | ,, total ingress | 12 10 34·6 | R. |
| ,, | I | Egress, first cont. | 14 14 42·9 | R. |
| ,, | I | ,, bisection | 14 18 42·3 | R. |
| ,, | I | ,, last cont. | 14 21 26·8 | R. |
| Feb. 28 | II | Eclipse, disapp. | 12 42 6·2 | E. |
| Mar. 11 | I | Eclipse, disapp. | 14 10 32·1 | D. |
| 25 | II | ($a$) Eclipse, disapp. | 9 43 25·3 | C. |
| ,, | II | Occ. reapp. bisection | 12 59 40·7 | C. |
| ,, | II | ,, last cont. | 13 0 55·5 | C. |
| 26 | III | Eclipse, disapp. | 13 20 57·1 | J. C. |
| 27 | I | Eclipse, disapp. | 12 25 34·9 | D. |

($a$) The satellite extremely faint, the observation very unsatisfactory.

The initials S., D., E., C., J. C., and R., are respectively those of Mr. Stone, Mr. Dunkin, Mr. Ellis, Mr. Criswick, Mr. Carpenter, and Mr. Roberts.

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### *Note on the Appearance of the Dark Ring of Saturn.*
By J. Carpenter, Esq.

During the observation of *Saturn* with the transit-circle, on the evening of March 26th, 1863, it struck me that the dark space between the ring and the ball seemed much contracted. Upon looking at it with the Equatoreal I found that this arose from a great increase in the brightness of the dusky ring, which appeared nearly as bright as the illuminated ring, and might easily have been mistaken for a part of it.

*Occultation of* B.A.C. 4006 *by the Moon, observed at Forest Lodge, Maresfield, by Capt. W. Noble, on Thursday, April* 2, 1863.

The star disappeared at

$12^h\ 9^m\ 46^s{\cdot}6$ L.S.T. $= 11^h\ 26^m\ 33^s{\cdot}62$ L.M.T.

Owing to the obliquity of the Moon's motion over it, and the immersion taking place near a high mountain, the star presented the appearance of a little sun setting; its spurious disc apparently descending and touching the lunar limb, just before its instantaneous disappearance. The reappearance was not observed.

Telescope employed: my Ross Equatoreal of 4·2 inches aperture, with a power of 255 adjusted on the star.

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## *Note on a Small Companion of Procyon, &c.*

By J. Gurney Barclay, Esq.

Towards the close of December, 1855, my attention was directed to the neighbourhood of *Procyon*, by a letter to the Editor of the *Times* from Mr. Hind, dated 21st of that month, in which he stated, that he strongly suspected the existence of some star or other body in the immediate neighbourhood of *Procyon*, by which the proper motion of that star was irregularly affected.

Being at that time in possession of an excellent Refractor, by Cooke, of $7\frac{1}{2}$ inches aperture, I took the earliest opportunity of closely inspecting the neighbourhood of *Procyon*, and on the 10th January, 1856, I discovered a small star within the blaze of the light of the larger one, and which I roughly estimated at from 3 to 4 seconds of time by the sound of the clock preceding *Procyon* in R.A., and but little removed to the North in December.

I communicated these particulars to Mr. Hind, accompanying them with a rough sketch of the relative position of the small star with the large one, and two others of small magnitude in the immediate vicinity. Mr. Hind having recently again called my attention to this object, I requested Mr. Romberg, who has the care of my Observatory, and which now contains a 10-inch Refractor by the same maker, to give it his best attention, and to endeavour to determine with some accuracy the exact position of the small star. This he has done, and given the result in the accompanying paper. I may add, that in order to get a very distinct view of the object, we found it necessary to make use of a ring micrometer, by which

the rays of light of the large star were shut off, by being brought behind the dark ring.

The other two minute stars which he notices, are clearly fainter than that above described, but are distinctly visible with the 10-inch aperture in the absence of the large star from the field.

Mr. Romberg has also given his attention to the measurement of the triple star of *γ Andromedæ*, and has succeeded in obtaining some satisfactory results.

*Leyton, Essex,*
*24th March*, 1863.

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## *Measures of the Small Star near Procyon.*
By Hermann Romberg.

I determined the position of this small star, which was first seen by Mr. Gurney Barclay in the year 1856, in reference to *Procyon*.

| | | | | | | |
|---|---|---|---|---|---|---|
| | 1863, March 17 | 295 18 | (6) | | | |
| | 18 | 295 40 | (6) | | | |
| | 19 | 294 25·5 | (6) | 44″·9 | (12) | |
| | 21 | 294 14·1 | (6) | | | |
| | 23 | 294 47·5 | (6) | 46·9 | (9) | |
| Mean | 1863·22 | 294 54 | (30) | 45·8 | (21) | |

I estimate the small star to be of the 10.5 magnitude.

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## *Measures of the Companion of γ Andromedæ.*
By Hermann Romberg.

I attacked this star with Mr. G. Barclay's excellent Refractor, during the winter, on several occasions, but was never very successful; but since the 17th of February, shortly after sunset, the star was shown clearly divided every time I looked at it with powers 750, 500, and 330. By means of a roughly introduced spider's line I obtained the following measures of position: —

| | | | |
|---|---|---|---|
| | 1863, Feb. 27 | 107 41 | (12) |
| | Mar. 18 | 105 43 | (6) |
| | 19 | 107 10 | (4) |
| Mean | 1863·20 | 107 3 | (22) |

I estimated the distance to be about $0''.6$, and the magnitudes of the stars 5 and 6.5.

*Mr. Gurney Barclay's Observatory,*
*Leyton, 1863, April 7.*

## *Observations and Elements of Comet I.* 1863.
By Hermann Romberg.

I have obtained the following observations of the Comet I., 1863 :—

| | M.G.T. | Δα Comet − Star. | Δδ Comet − Star. | |
|---|---|---|---|---|
| | h m s | m s | ′ ″ | |
| 1863, Jan. 11 | 15 55 59·5 | +9 15·230 | +5 13·5 | *a* |
| 20 | 17 51 59·4 | 0 41·951 | +7 9·4 | *b* |
| 24 | 17 58 35·5 | 1 36·834 | +4 54·3 | *c* |
| Feb. 3 | 16 59 16·0 | 0 17·832 | −4 30·0 | *d* |
| | 17 39 9·5 | +0 22·540 | −5 18·1 | *d* |

The apparent places of the stars of comparison for the date of observation are,

| | | | |
|---|---|---|---|
| | h m s | ° ′ ″ | |
| (*a*) | 17 41 19·20 | +38 56 8·5 | Radcl. |
| (*b*) | 19 16 28 | 34 2 0 | Lal. |
| (*c*) | 19 38 21·41 | 31 45 11·7 | B. Z. |
| (*d*) | 20 17 5·88 | +26 41 30·8 | B. Z. |

The star (*b*) is given in Argelander's Northern Zones, Zon. +34°.

On Feb. 3d I compared the Comet with another star, and obtained, for the above times,

| | | m s | ′ ″ |
|---|---|---|---|
| Feb. 3 | | −1 34·568 | −3 20·2 |
| | | −1 29·660 | 4 11·1 |
| | $18^h\,22^m\,5^s.0$ | −1 24·547 | −5 6·1 |

The apparent place of this latter star is nearly

$20^h\,18^m\,28^s.19$ $\quad +26°\,40'\,22''.3$

The differences in Right Ascension and Declination are corrected for Refraction and Parallax ; they are the means of at least six transits. The Comet's appearance was round and faint ; but I discerned from the 20th of February a faint nucleus, which had on the 3d of February increased consider-

ably in brightness. Unfavourable weather in the morning hours prevented me from observing it any further.

I calculated the following parabolic elements from the observations, Berl., Dec. 5, Dec. 26, Leyton, Jan. 11, taking into the account the corrections of Aberration and Parallax:—

| | | |
|---|---|---|
| T | 1863, Feb. 3·48790 M.G.T. | |
| | ° ′ ″ | |
| $\pi$ | 191 22 12·4 | Mean Eq. 1863·0 |
| $\Omega$ | 116 55 19·7 | |
| $i$ | 85 21 34·2 | |
| log $q$ | 9·9002614 | |
| | Direct. | |

These elements give for the mean place the error

C − O $\quad \Delta\alpha = -0''\cdot7 \quad \Delta\delta = +7''\cdot1$

---

*On a mode of Figuring Glass Specula for the Newtonian Telescope.* By the Rev. Henry Cooper Key.

As the subject of silvered glass specula is now beginning to attract some attention, I have taken the liberty of laying before the Society a brief account of the successful manufacture of these specula, including a method which I have suggested for producing with great ease and certainty the true parabolic figure necessary for first-rate performance.

The machine used for the purpose is the same in principle as that of the Earl of Rosse, and very similar in detail, but with some slight modification in the speed of the various parts. The number of strokes to one revolution of the speculum-plate is 104. The pin of the eccentric giving the side motion is carried from side to side with an unequal velocity by means of an oval wheel, whereby the centre is passed over rapidly and the action is prolonged at the two extremes. The number of revolutions of the side-motion eccentric to one revolution of the speculum-wheel is $5\frac{1}{2}$. The amounts of stroke and side-motion found to produce the best results are stroke = $\frac{1}{3}$ diameter of the speculum and side-motion $\frac{1}{4}$ the same; but precision on this point does not appear to be very material.

The glass disc is ground upon a cast-iron tool, of the same diameter as itself, carefully turned to the guage, and scored at right-angles into facets $\frac{5}{8}$-in. square; these grooves are filled up with wax or pitch until the rough grinding is complete, or nearly so. It is not absolutely necessary to work a concave iron tool upon the convex, the simplest plan being to figure

the convex tool by means of the speculum itself; or, if more than one is to be worked, by grinding them alternately upon it. The convex tool should be turned to a curve giving about 6 inches less focal length than that ultimately desired, to allow for the lengthening that will take place in the course of the grinding.

The fine grinding is effected by means of emery of six different degrees of fineness, commencing with flour-emery as No. 1; these are, of course, obtained by washing and pouring off the finer particles while in suspension. The sixth, or finest quality, takes between two and three days to settle. The last application is slate-mud, carefully washed, and mixed with a very little rouge, also washed. Rouge always contains some amount of grit, and should never be used unwashed.

As the character of the spherical figure, upon which the quality of the future mirror entirely depends, is given in fine grinding upon the iron tool, it is advisable to prolong the process of fine grinding considerably, and to bring the surface, in fact, to such a fine degree of semi-polish, that, when placed with wet rouge on the pitch-tool, it shall come up to a perfect polish in from three to four hours. The shorter the sojourn of the speculum on the pitch-tool the better. I need scarcely add that no rings of unequal polish ought to appear during any part of the fine grinding.

The pitch polishing tool may be made either of two pieces of seasoned wood glued together across the grain, or of slate. It should be turned to the guage, and, as it should be of the same size as the speculum when coated with pitch, it must be about $1\frac{1}{2}$ inches larger in diameter, to allow of the margin being perfect. The pitch is hardened with resin, until the thumb-nail can make little or no impression upon it when cold: the harder it is the better, provided it be not too brittle. It is to be scored, while still warm, into squares or facets, which, after some hours' work upon the machine, shall not exceed $\frac{1}{2}$-in. square on the surface, and shall stand at least $\frac{3}{8}$-in. high, the base of each facet being not less than $\frac{7}{8}$-in. square. It is of great importance that they stand well detached from one another, that they may give equally to pressure in all directions. In polishing, as well as in grinding, the speculum is placed uppermost.

The speculum, when polished and placed in the tube, and directed to a fine watch-dial at about 100 yards' distance, will now show that the extreme marginal rays come to a focus about $\frac{1}{4}$-inch inside the central rays—proving thereby a spherical figure.

To give the parabolic figure, which shall unite all the rays in one precise focus, proceed with a sharp chisel to cut the facets of the pitch-tool smaller, leaving the four centre ones untouched, and gradually diminishing the surface of the others over the whole face of the tool, until those at the margin are

reduced to $\frac{1}{4}$-inch square, or even a little less. The proper amount of graduation is obtained by experience, and upon the judicious execution of this the quality of the speculum will depend. The speculum is now placed upon the graduated tool, and the action of the machine continued with the same amount of stroke and side-motion as before, until, supposing its surface divided by diaphragms into four nearly equal zones—outer, second, third, and central—it gives equally perfect definition on the dial, and bears an equally high power, with each zone, at precisely the same focal point. This is attained usually in a few hours, without any difficulty. I ought perhaps to add, by way of caution, that the stroke and side motion must not be altered in amount in the slightest degree from the commencement of the fine grinding to the completion of the figure, and more especially the side motion.

This is the normal mode of procedure; but, by way of precaution, it is advisable to graduate the pitch-tool very slightly before commencing the polishing; and when that is quite perfect (and not the slightest granulation must be left visible), the tool is to be fully graduated, as before stated.

My first experiment with the graduated tool, when the idea occurred to me, was made on a half-polished mirror, and in two and a half hours the definition became such as to surprise me. With a half-polished mirror, unsilvered, 12-inches aperture and power of 1000, the dial was exquisitely defined; with 350 the effect was that of viewing the dial itself close to the eye without the intervention of a telescope; and a fly resting on the well-focussed dial remained itself out of focus, with the exception of its feet, forcibly reminding me of the definite focal plane of a good achromatic microscope: the mirror, in fact, came up to focus and went out—in an instant—with the sharp precision of a microscope.

No more severe test is required, or indeed can be found, to insure fine performance on celestial objects, than the dial, and the mode of procedure above mentioned.

The speculum is to be silvered by Liebig's process; and the coat should be rather thin, as, if thick, it is liable to lose its fine figure by rubbing up. The silver will never tarnish if kept dry. A small bag should be kept in the same box with it, containing sawdust which has been saturated with chloride of calcium, and dried.

Circumstances over which I had no control have prevented my own further progress, and, indeed, I shall be delayed some weeks longer before I am able to resume the work; but having, last autumn, communicated my method to Dr. Frankland, of the Royal Institution, and to Mr. With, Master of the Bluecoat School at Hereford, I am able to state what they have accomplished.

Dr. Frankland immediately and readily figured a speculum of 7 inches' aperture, whose spherical figure was not good (it

having been polished by hand on paper), so that it would split 36 *Andromedæ* with 210, clearly and sharply. He, however, expects superior results from a machine-made speculum, and speaks in the highest terms of my suggestion of the graduated pitch-tool.

Mr. With, of Hereford, in his small intervals of leisure during the last three months, has completed three or four glass specula of the highest class, $6\frac{1}{4}$-inches aperture and 6-feet focus, and $5\frac{1}{2}$-inches aperture and $4\frac{1}{2}$-feet focus. With the larger telescope he is able to elongate the disk of the small companion of $\gamma$ *Andromedæ* readily. Its definition of a large fixed star is remarkably fine, giving a perfectly round clean disk, surrounded at a little distance by one faint concentric ring, and without any other appendage or false light whatever.* This was his first attempt. One of his $5\frac{1}{2}$-inches specula is, however, slightly superior to this, and is presumed to be perfect: not the least trace of error of figure can be detected over the entire surface after the strictest scrutiny.

The belief is, after sundry trials and comparisons with achromatics, that the silvered-specula Newtonian is very little, if at all, inferior in efficiency to the finest achromatic of the same aperture. Should this be confirmed by future experience, as I fully anticipate it will be, the former will prove to be formidable rivals to the latter, as the cost of making is not likely to amount to one-eighth or even one-tenth of the achromatic object-glass.

I have omitted to mention that excellent small glass flats for silvering may be obtained from the common French plate-glass—the best from the middle of the plate.

Should any member of the Society desire further information beyond what I have been able to convey in these brief notes, I shall be happy to give it at any time.

*Stretton Rectory, Hereford,*
*March 9th*, 1863.

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## *Companion of Sirius.*

(*Extract of a Letter from the Rev. W. Dawes.*)

"Goldschmidt's star *d* near *Sirius* is easy enough, but I have not been able to perceive any of the others. In fact, such

* The fifth star in the trapezium in *Orion* is visible as a steady object, and the sixth in moments of fine vision. The distant comes of $\lambda$ *Orionis*, not mentioned by Smyth, is an easier object in this telescope than the fifth star in the trapezium. In the triple star $\zeta$ *Orionis* the separation between the close pair is equal to one diameter of the large star with a power of 220.

an object is far less a *telescopic*, than an *atmospheric test* in these latitudes. The star should be examined at the Cape of Good Hope."

*Hopefield, Haddenham, 10th April*, 1863.

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Mr. Carrington, in reference to the subject of the Motion of the Solar System in Space, remarks as follows:—

"I have just become acquainted with the circumstance, that in 1859 a Royal Medal was offered for competition in the University of Christiania for the best Memoir to be received in 1860, containing an investigation whether the mean direction of motion of the Comets before coming under solar influence differed from the concluded motion of the Sun, and that the award was made to Candidate Mohn for a Memoir just published under the professorial superintendence of Prof. Fearnley. Very curiously, as it appears to me, the attack is conducted by the only way which I can conceive different to the process I followed myself in 1860, in a short Memoir which the Society did me the honour to publish. Mr. Mohn, after selecting 173 orbits, and throwing out the periodical ones, searches to find whether there is any region of the heavens approaching a great circle belt, in which the poles of the several planes of motion are chiefly congregated, and finding such a belt of preponderance and fairly regular distribution, points out that the axis of this belt will be the general direction of cometic motion as defined. His conclusion is, that the direct and retrograde Comets concur in giving a mean direction of motion towards long. 0° lat. $+ 10\frac{1}{2}°$, or nearly at right angles to the general conclusion for solar motion.

"But Prof. Fearnley, who appears, as proposer of the Problem in Christiania, to take much personal interest in it, points out in his commentary that the direction found in the Memoir is greatly attributable to the special circumstances attending the discovery of Comets, which, it will be remembered, I had also occasion to dwell upon in considering the conclusions of my own investigation. These are

"1 The discovery generally between sunset and midnight.

"2 Observers mainly in northern hemisphere.

"3 The heliocentric elongation of the Comet being commonly acute.

"He goes so far as to say, that examining the effects of these circumstances, he obtains, as a direct and necessary consequence therefrom, the result arrived at by Mr. Mohn.

"The attack on this problem by way of the orbits appears, therefore, by two independent inquiries, to be hopelessly

nugatory; and it becomes the more desirable that the older route of research should be promoted by the improving the data needful for its success, namely, well determined stellar residual motions; the whole subject at present seeming, on critical examination, to be less advanced than once supposed, though presenting hopes of successful future research."

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### *Minor Planet* (77).

The discovery of this minor planet by Dr. Peters, and his observations of it Nov. 1862, are mentioned *Monthly Notices*, *ante*, p. 76, and in the *Ast. Nach.* No. 1399. No further observations appear to have been made, nor any elements computed.

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### *Minor Planet* (78), *Diana.*

The discovery, by Dr. Luther, Director of the Observatory of Bilk, is announced *Ast. Nach.* No. 1408; the planet was seen of the magnitude 10, the position being

1863, March 15, $13^h\ 24^m\ 14^s{\cdot}4$ Bilk M.T. R.A. $180°\ 12'\ 6''{\cdot}8$.
Decl. $-7°\ 20'\ 3''{\cdot}4$.

the retrograde motion being more than 2 seconds of time in the hour.

The following elements, calculated from the Bilk Observation of 15 March, and from observations at Bonn, March 23 and 31, have been calculated by Herr Tiele of Bonn, *Ast. Nach.* No. 1410.

Epoch, 1863, March 15·0, Berlin M.T.

| | | | |
|---|---|---|---|
| M | = | 39° 50′ 29″·0 | |
| $\pi$ | = | 121 6 30·3 | Equinox, 1863·0. |
| $\Omega$ | = | 334 1 19·3 | |
| $i$ | = | 8 39 4·8 | |
| $\varphi$ | = | 11 59 38·8 | |
| $\mu$ | = | 833″·877 | |
| Log $a$ | = | 0·419270 | |

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## RECENT PUBLICATIONS.

*Untersuchungen über veränderliche Eigenbewegungen von G. F. J. Arthur Auwers. Erster Theil: Bestimmung der Elemente der Procyonbahn und Untersuchung der für veränderlich gehaltenen Eigenbewegungen von α Virginis, β Orionis und α Hydræ. Nebst einem die Reduction eines Theils der Beobachtungen an den Mittagsfernröhren von Greenwich und Palermo von 1765 bis 1810 enthaltenden Anhang. Inaugural Dissertation.* 4°, Königsberg, 1862, pp. 1–96.

The researches on Procyon, *Ast. Nach.* Nos. 1371 73 (an abstract of which is published, *Monthly Notices, ante*, pp. 18–20), are, in fact, an extract from this elaborate memoir; the title shows what are the other stars to which M. Auwers has extended his investigations.

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For Sale: A Marine Box Chronometer, the property of Mr. Carrington. Price 18*l.* It was cleaned and put in thorough order last year, and may be seen, and its rates inspected, at Mr. Frodsham's, in the Strand, where it has since remained, from the owner having no further use for it.

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### ERRATA

*In No. 5 of the Monthly Notices, Vol. XXIII.*

Page 165 (heading), *for* Latitude, *read* Longitude.

— —, lines 1 and 2, *for* Kingston, *read* Kingstown.

— —, line 28, *for* R. J. Leckie, *read* R. J. Lecky, Esq.

— 166, — 22, *for* Knightstown, *read* Kingstown.

— 167, — 20, *for* apparent movements of the bodies in space, *read* apparent movements on the surface of a globe to the real movements of the bodies in space.

— 168, — 11, *for* 524°·54, *read* 514°·54.

— —, — 17, *for* 15° 31′, *read* 15°·31.

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